

REMARKS

Withdrawal of Previous Rejection

Applicants acknowledge the withdrawal of the rejection of claims 1-20 under 35 U.S.C. §103(a) over U.S. Patent No. 5,077,422 to Hara et al. as set forth in the Office Action dated November 20, 2007.

Rejection of Claims 1-20 Under 35 U.S.C. §103(a)

Applicants respectfully request reconsideration of the rejection of claims 1-20 under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 5,077,422 to Hara et al. in view of U.S. Patent No. 4,301,077 to Pesa et al.

Claim 1 is directed to a homogeneous process for the hydrogenation of dicarboxylic acids and/or anhydrides. The reaction is carried out in the presence of a homogeneous catalyst comprising (a) ruthenium, rhodium, iron, osmium or palladium; and (b) an organic phosphine. That is, the catalyst is dissolved in the solvent for the reaction and that at least some of the water present and at least some of the dicarboxylic acid and/or anhydride must be in phase with the catalyst (See paragraph [0030] of applicants' published application, Pub. No. US 2007/0142679 A1). Claim 1 further requires that the reaction be carried out in the presence of at least about 1% by weight water and conducted at a pressure of from about 500 psig to about 2000 psig and at a temperature of from about 200 °C to about 300 °C such that from about 1 mol to about 10 mol of hydrogen are used to strip 1 mole of product from the reactor. The claimed process provides for the production of cyclic ethers, lactones and diols from dicarboxylic acid or anhydrides in

which the presence of the water allows for reaction conditions to be utilized in which the desired product can be continuously removed from the reactor using a much lower hydrogen stripping rate than has been achievable before. The claimed process and the attendant advantages are neither taught nor suggested by any of the documents relied on in the Office action.

The Office acknowledges that Hara et al. fails to teach or suggest the claimed process conducted in the presence of at least 1% by weight water. To cure this deficiency the Office now cites Pesa et al.

Pesa et al. is directed to the manufacture of tetrahydrofuran and 1,4 butanediol by contacting oxygenated C<sub>4</sub> hydrocarbons and hydrogen in the liquid or gas phase with a solid (i.e., heterogeneous) mixed-metal oxide catalyst containing ruthenium and three other metals, most typically nickel, cobalt, and zinc (See col. 2, lines 15-30). Pesa et al. disclose that the water content during the reaction should minimized (preferably, less than about 10 wt.%) because it is believed that water inhibits the hydrogenation reaction (See, for example, col. 3, lines 26-41). Pesa et al. is cited by applicants at paragraph [0005] of their published application, Pub. No. US 2007/0142679 A1, as representative of heterogeneous precious metal systems developed to allow the use of an acid starting material in the presence of water.

Contrary to the Office's contention, the teaching in Pesa et al. that the heterogeneous catalysis system described therein can function without significant detriment in the presence of water does not suggest to one skilled in the art that a homogeneous hydrogenation process

could likewise be conducted in the presence of significant amounts of water.

The catalyst and process of Pesa et al. is manifestly different from the catalyst and process of claim 1. It is recognized by those skilled in the art that heterogeneous catalyst systems and homogeneous catalyst systems are distinct disciplines that operate by very different mechanisms such that teachings with respect to one discipline are not readily applicable to the other. For example, the activity of a heterogeneous catalyst of the type used in Pesa et al. is highly dependent upon adsorption of reactants from and desorption of product into the reaction medium at the interface with the catalyst surface. In contrast, in homogeneous catalysis systems of the claimed invention, such transport constraints are obviated as the catalyst is in the same phase as the reactants. That is, surface adsorption/desorption transport limitations do not apply to homogeneous catalysts (although they are affected by other factors such as inhibition). Furthermore, it is well-known in the art that differing catalyst activity and/or stability issues are encountered as between heterogeneous catalysis and homogeneous catalysis systems. In the claimed process, the homogeneous metal catalyst (e.g., ruthenium) is dissolved in the solvent for the reaction and the ruthenium metal is in a higher oxidation state. By contrast, the heterogeneous metal oxide catalyst of Pesa et al. contains ruthenium and other metals which are present in the zero oxidation state. Since the ruthenium metal is in very different oxidation states, there would not be an expectation that the interaction of water with the

heterogeneous catalyst and impact on catalyst activity and stability would be analogous in a homogeneous catalyst system.

On page 4 of the Office Action, it is noted that the heterogeneous catalyst system of Pesa et al. does not include organic phosphine component as required in the claimed process. However, the Office fails to recognize the significance of this difference as it relates to the proposed combination of disparate teachings. In the claimed homogeneous process, the catalyst includes organic phosphine to stabilize and improve the activity of the metal catalyst dissolved in the solvent under reaction conditions. Pesa et al. does not include an organic phosphine for the very reason that catalyst stability and activity considerations are different in the heterogeneous catalysis system and the mechanisms of providing a stable, active homogeneous catalyst dissolved in the reaction solvent simply do not apply.

Whatever Pesa et al. and similar teachings in the prior art may suggest about the ability of heterogeneous precious metal catalysts to function acceptably in hydrogenation systems in the presence of water, such teachings do not render operation of a homogeneous process in the presence of at least 1% by weight water "within the purview of those of ordinary skill." Indeed, if the proposed extrapolation were plausible, there would have been no need to develop the expensive heterogeneous precious metal catalysts of Pesa et al. and others for hydrogenation systems conducted in the presence of water.

On page 3 of the Office action, it is acknowledged that Hara et al. fails to explicitly teach that about 1 mol

to about 10 mols of hydrogen are used to strip 1 mol of product from the reactor, but that one skilled in the art would expect the claimed molar ratio to be covered by the disclosed process given the pressure and temperature ranges. However, as previously pointed out by applicants, in the main example of Hara et al. in which a dicarboxylic acid or anhydride is used as a feed (succinic anhydride in Example 9), the hydrogen to product ratio is approximately 107:1. Thus, Hara et al. teach the use of a vast excess of hydrogen. The large molar excess of stripping hydrogen to product (as compared to the claimed ratio of about 1:1 to about 10:1) indicates to the skilled person that a large amount of hydrogen is used to strip out the byproduct water from the system and reduce the water concentration to as far as possible and preferably to near zero. Such teaching is contrary to the process as claimed which does not require that the water be stripped out but, rather, requires that at least 1% of water by weight be present during the hydrogenation reaction to achieve the benefits attendant the presence of water discussed above.

Further, the Office fails to articulate any reasoning why the pressures disclosed in Hara et al. are result-effective such that the system disclosed therein requires about 1 mol to about 10 mol of hydrogen to strip 1 mole of product from the reactor. To the contrary, as previously pointed out by applicants, Hara et al. teach that the amount of water present during the reaction should be minimized (i.e., that a large excess of hydrogen used as a stripping gas is required as consistent with Example 9 of Hara et al.).

The deficiency of the primary reference with respect to the claimed molar ratio of from about 1 to about 10 mols of hydrogen used to strip one mol of product cannot be overcome by resort to Pesa et al., which likewise uses a large excess of hydrogen to strip out the product and account for the presence of significant quantities of water.

In view of the above, applicants respectfully submit that the acknowledged deficiencies in the primary reference are not overcome by resort to Pesa et al. and the proposed combination of references fails to establish a *prima facie* case of obviousness as to claim 1. It is further respectfully submitted that claims 2-20 that depend directly or indirectly from claim 1 are not obvious in view of this combination of references for the reasons set forth above regarding claim 1 and the additional limitations which they introduce.

Favorable reconsideration and allowance of all pending claims are respectfully requested.

Applicants authorize the Commissioner to charge any government fees that may be required in connection with this response to Deposit Account No. 19-1345.

Respectfully submitted,

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